

*Original Research*

# **Effectiveness of *Cymbopogon citratus* (Lemongrass) oil and *Ocimum basilicum* (Basil) oil as an Organic Anti-Mosquito Agent against *Aedes aegypti***

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## **ABSTRACT**

Mosquitoes are the type of agents that people are eager to eliminate, as they disturb sleep, relaxation time, or any type of activities. This study aimed to investigate the effectiveness of an alternative intervention against the proliferation of mosquitoes. The purpose of this study was to create an organic anti-mosquito agent in the form of oil against *Aedes aegypti* by extracting oil from *Cymbopogon citratus* (Lemongrass) and *Ocimum basilicum* (Basil). The samples were mixed with water and boiled to extract the oil. The oil extracts in this study were classified into three categories; lemongrass oil, basil oil, and a combination of lemongrass and basil oil that consisted of 50% of each extract. Lemongrass oil showed mortality rates of 51.1% (23/45) for the first hour, 59.5% (25/42) for the second hour, and 74.3%, (26/35) for the third hour. Basil oil showed mortality rates of 43.8% (14/32), 41.7% (15/36), and 28.6% (10/35) in the same time intervals. Lemongrass-basil oil showed mortality rates of 44.4% (20/45), 52.8%, (19/39), and 60%, (18/30) respectively. Results showed that among the three organic anti-mosquito oils that were used, the lemongrass oil and lemongrass-basil oil were effective. This was concluded due to the increased mortality rates of the lemongrass oil and lemongrass-basil oil in each trial as it both reached the 50% mortality rate in killing mosquitoes on the basis of lethal concentration.

**Keywords:** mosquito, *Aedes aegypti*, lemongrass, basil, lethal concentration, organic oil extract

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## **INTRODUCTION**

One of the most common insects that humans encounter is the mosquito. Mosquitoes are the kind of insect people want to get rid of because they usually ruin your sleep or relaxation time. According to the Illinois Department of Public Health, there is no doubt that mosquitoes are the most dangerous creatures on earth. Every year, millions of

people die as a result of their ability to carry and spread diseases to humans. Dengue fever's global incidence has increased 30-fold in the last 50 years, and more countries are reporting their first outbreaks of the disease (CDC, 2021). Mosquitoes and the diseases they spread have been responsible for killing more people than all the wars in history. There are a lot of diseases that mosquitoes can transmit. Some of the most common diseases are dengue, malaria,

chikungunya, yellow fever, and Zika fever. The U.S. Army came up with DEET (N, N-diethyl-3-methylbenzamide) in 1946, which is a man-made insect repellent (EPA, 2022). For years, DEET has been commonly found in insect repellents as an active ingredient. In our generation now, many kinds of insect repellents are already available on the market. People are much safer and better protected from dangerous insects like mosquitoes now that there are insect repellents on the market. However, the use of DEET and other synthetic mosquito repellents can harm not only mosquitoes but also the environment (EPA, 2022). Mosquitoes can also be kept away with things that we normally bring in and out of our homes. Mosquito repellents have progressed into one of the most effective means of preventing disease transmission and the discomfort caused by mosquito bites. Natural products, including essential plant oils, have been used as repellents for at least two millennia in China, Egypt, and ancient India. In recent years, hundreds of studies on plant derivatives with repellent properties have been published. (Zhu et al., 2018) Organic materials that usually linger in and out of our homes can also be used in repelling mosquitoes. Natural repellents are found to be safe and better for the skin. Plant based repellents are chemical free and have many advantages over the chemical based repellents. Varieties of plant based mosquito repellents are available in the market. As well as, one can easily prepare mosquito repellent formulations with the natural ingredients available at home. Ingredients like garlic, neem, cloves, camphor, cinnamon, bay leaves, lavender are easily available at home, which are utilized to prepare mosquito repellents which are totally safe and effective and are chemical free. The home-made formulations are found to be effective as

well as promote a good safety profile. (Sheikh et al., 2020).

Organic materials that usually linger in and out of our homes can also be used in repelling mosquitoes. One of the commonly known organic repellents is the lemongrass oil. Lemongrass (*Cymbopogon citratus*) and lemongrass oil is usually used in adding flavor and aroma in our food and it has a lot of benefits in terms of medicine. Lemongrass oil contains insecticidal properties that repel insects. Lemongrass essential oil (LEO) contains a significant amount of bioactive compounds such as citral (a geranial and neral mixture), isoneral, isogeranial, geraniol, geranyl acetate, citronellal, citronellol, germacrene-D, and elemol, among other bioactive compounds. These components give LEO pharmacological properties such as antifungal, antibacterial, antiviral, anticancer, and antioxidant properties (Mukarram et al., 2021). Citral is one of the major constituents of the lemongrass oil and it gives the lemony fragrance that helps in repelling mosquitoes.

On the other hand, basil's different varieties are mainly attributed to varying chemical constituents due to variations in temperature, humidity, acidity, and other environmental factors. It contains appreciable quantities of fatty acids, but essential oil obtained from plant leaves is of extreme importance due to diverse applications ranging from flavoring agents to therapeutic medicines. It is known to have strong synergistic and analgesic effects antithrombotic, along with antiplatelet, antihypertensive, phyto remediatary, antihepatotoxic, anticolic, cytotoxic, anxiolytic or sedative, antiosteoporotic, anticardiovascular, antistress, immunomodulatory, radio protective, antimalarial, insecticidal, antidiabetic, antiulcer,

anti-inflammatory, antifungal, antibacterial, antiviral, anticancer, and antioxidant properties. (Nadeem et al., 2020).

## METHODS

### Research Design

This study used experimental research design to determine the effectiveness of *C. citratus* and *O. basilicum* as organic anti-mosquito agents against *A. aegypti* in a test cage. The concentration of the *C. citratus* and *O. basilicum* was controlled. Experimental research design uses two variables. By using this research design, it ensures that the accuracy of the factors presented is maximized. The dependent variable relies on the independent variables presented in this study (Bell, 2017).

The independent variables are the *C. citratus* and *O. basilicum*; the dependent variable are the mosquitoes. The dependent variables rely on the effectiveness of the two independent variables mentioned above.

### Setting of the Study

In this study entitled “Effectiveness of *Cymbopogon citratus* (lemongrass) and *Ocimum basilicum* (basil) as Organic Anti-Mosquito Agent against *Aedes aegypti*”, the plant extracts that was used in this study was collected in the community of the researchers and the mosquitoes was bred in dirty stagnant water. Consequently, the experiment was conducted in the laboratory of Emilio Aguinaldo College Manila for an estimated time frame of one (1) month.

### Preparation of Materials

Since the researchers aimed for the efficiency of the organic anti-mosquito agent, specific materials are needed to perform the experiment. For this study, the researchers needed mosquitoes that are used to be the subject for the testing of the organic anti-mosquito agents. The organic anti-mosquito agents that are used for this study were the following: lemongrass oil, basil oil, and lemongrass-basil oil.

### Collection and Identification of Plant Materials

The plant materials such as *C. citratus* and *O. basilicum* that are used for this experiment was obtained from the community of one of the researchers in Maharlika Village, Taguig City. The plants that are used in this study are identified and authenticated by the University of the Philippines Institute of Biology in Diliman, Quezon City.

### Preparation of Mosquitoes used for the experiment

The mosquitoes that are used for this experiment were bred in dirty stagnant water. The mosquito that was used in this study was identified by the Museum of Natural History in University of The Philippines Los Baños, Laguna. The number of mosquitoes that were used for the whole experiment was approximately five hundred eighty-five (585) mosquitoes since for each test, approximately forty-five 45 mosquitoes are used and there are five (5) anti-mosquito agents that were used in this study, including the negative and positive control group and the test for each agent are repeated three (3) times.

### Handling of Mosquitoes

After the breeding of mosquitoes, the mosquitoes have been put in a clean and empty gallon bottle. The top of the bottle was sealed by a

clean cloth so that the mosquitoes can still have proper ventilation of air. The food of the mosquitoes was a sugar solution and they were fed every 4 days.

### Preparation of Mosquito Cage

A size of 45 x 50 x 45 cm test cage was used for the experiment. The frame of the test cage was made from wood. All of the sides of the test cage were covered with observable mosquito nets for the researcher to be able to see the inside. The wood and mosquito nets that have been used in this study were acquired from the hardware stores around the community of the researchers. One side of the test cage was made accessible to be the entrance for the mosquitoes and the organic mosquito diffuser.

### Preparation of Organic Oil for Diffuser

The samples were first chopped into small pieces and then weighed. After weighing, the researchers placed the sample of the *C. citratus* and *O. basilicum* in the RB flask with half of its level with distilled water. The researchers mixed the sample by shaking the RB flask carefully. Then, the experiment started by heating up the flask to 90-100 degree Celsius in an electric heating mantle until it starts to boil. After it boils, the heat is lowered to 40-50 degree Celsius. The set-up is left for 1-2 hours. When it starts to boil, the oil and water vapor slowly evaporates and moves upward and reaches to the condenser and both of the condense gets collected to the glass pipe to collect the oil.

Table 1. Plants that are used as organic anti mosquito agent

| PLANT                      | FAMILY    | COMMON NAME        | PART USED |
|----------------------------|-----------|--------------------|-----------|
| <i>Cymbopogon citratus</i> | Poaceae   | Lemongrass/Tanglad | Leaves    |
| <i>Ocimum basilicum</i>    | Lamiaceae | Basil              | Leaves    |

Table 2. Components of organic anti-mosquito oil for the diffuser that was used in the experiment.

| PLANT            | WATER (mL) | OIL     |
|------------------|------------|---------|
| LEMONGRASS       | 100mL      | 3 drops |
| BASIL            | 100mL      | 3 drops |
| LEMONGRASS-BASIL | 100mL      | 3 drops |

### DATA COLLECTION

The collections of data are done by recording the number of mosquitoes who died on the process during the observation time. The duration of observation for the testing of each organic anti mosquito agent including the control test was 60 minutes. Three (3) repetition of this process was done to complete the data needed by the researcher.

### DATA ANALYSIS

The data were evaluated for the mortality rate of each organic anti-mosquito agent to determine if there is a difference between the control group and the treated groups, and also a difference within the data collected from the treated groups. The results from this analysis were determined if the organic anti-mosquito agents were effective against the mosquitoes. Furthermore, this was used to determine if each of the organic anti mosquito agent's effectiveness were different from each other.

### RISK ASSESSMENT

The work makes use of a pathogenic insect vector that could represent a hazard to human

well-being. Due to possible occurrence, the study strictly adhered in accordance with the Guidelines for biosafety and biosecurity in mosquito rearing facilities. Thus, the mosquitoes must be collected, handled, and disposed of properly with personal protective equipment (PPEs) to prevent unnecessary injuries (FAO/IAEA, 2021).

## RESULTS AND DISCUSSION

The purpose of this study was to determine if the organic anti-mosquito agent made from the oils of *C. citratus* and *O. basilicum* are effective against *A. aegypti* and its differences in terms of their effectiveness in different duration and mortality of the mosquitoes inside the cage. However, due to limited time during the course of the experiment, only single exposure of the experimentation was done.

Table 3. Results in 1 hour of lemongrass oil, basil oil, and lemongrass-basil oil of the experimentation together with the control groups.

| EXTRACT/OIL      | No. of mosquito died (1 hour) |      |                |
|------------------|-------------------------------|------|----------------|
|                  | Population                    | Died | Mortality Rate |
| Lemongrass       | 45                            | 23   | 51.1%          |
| Basil            | 32                            | 14   | 43.8%          |
| Lemongrass-Basil | 45                            | 20   | 44.4%          |
| Positive control | 29                            | 29   | 100%           |
| Negative control | 32                            | 0    | 0%             |

Table 3 interprets the data gathered in the first hour of the experiment. For lemongrass oil, the population started with 45 mosquitoes. 23 of them died, and it has a 51.1% mortality rate. For basil oil, the population started with 32 mosquitoes. 14 of them died, and it has a 43.8% mortality rate. For the combined oil of lemongrass and basil, the population started with 45 mosquitoes. 20 of them died, and it has a 44.4% mortality rate.

The lemongrass oil reached 51.1% killing rate, since it has geranyl acetate and citral that exhibits insecticidal activity (Plata-Rueda et. al., 2020). It also reached the 50% killing rate which means that it is effective in killing mosquitoes based on the definition of lethal concentration wherein half of the population dies after a certain period of exposure (CCPS, 2023). Basil oil reached 43.8% killing rate because it has compounds such as linalool, estragole, 1,8 cineloe,  $\alpha$ -pinene, germacrene,  $\beta$ -pinene, hexadecenoic acid, farnesene, menthol pulegone, ocimene, D-camphor etc., which may be the inherent character for its toxic nature to the mosquitoes(Naveen et. al., 2020) However, basil oil does not reach the 50% mark for the LC50. For the combined oil of lemongrass and basil, it reached 44.4% killing rate in spite of having both of the beneficiary components of lemongrass and basil.

Table 4. Results in 2 hours of lemongrass oil, basil oil, and lemongrass-basil oil of the experimentation together with the control groups.

| EXTRACT/OIL      | No. of mosquito died (2 hours) |      |                |
|------------------|--------------------------------|------|----------------|
|                  | Population                     | Died | Mortality Rate |
| Lemongrass       | 42                             | 25   | 59.5%          |
| Basil            | 36                             | 15   | 41.7%          |
| Lemongrass-Basil | 39                             | 19   | 52.8%          |
| Positive control | 35                             | 35   | 100%           |
| Negative control | 32                             | 0    | 0%             |

Table 4 interprets the data gathered within the two hours of the experiment. For lemongrass oil, the population started with 42 mosquitoes. 25 of them died, and it has a 59.5% mortality rate. For basil oil, the population started with 36 mosquitoes. 15 of them died, and it has a 41.7% mortality rate. For the combined oil of lemongrass and basil, the population started with 39 mosquitoes. 19 of them died, and it has a 52.8% mortality rate.

It has been demonstrated that lemongrass oil effectively kills mosquitoes based on the increased mortality rate of mosquitoes found in lemongrass. Due to the presence of active components such

flavonoids, saponins, tannins, and essential oils that are harmful to mosquitoes, basil leaf extract has a bio insecticide impact on *A. aegypti* (France et al., 2020). However, despite having these active components, the basil oil still cannot kill half the population of mosquitoes in this period of time. The mortality rate for the Lemongrass-Basil combination is 52.8%. The killing rate in lemongrass-basil oil increased in this period of time because of the different active components that the lemongrass and basil has. Both the lemongrass oil and lemongrass-basil oil reached the 50% killing rate which means that it is effective in killing mosquitoes based on the definition of lethal concentration wherein half of the population dies after a certain period of exposure (CCPS, 2023).

Table 5. Results in 3 hours of lemongrass oil, basil oil, and lemongrass-basil oil of the experimentation together with the control groups.

| EXTRACT/OIL      | No. of mosquito died (3 hours) |      |                |
|------------------|--------------------------------|------|----------------|
|                  | Population                     | Died | Mortality Rate |
| Lemongrass       | 35                             | 26   | 74.3%          |
| Basil            | 35                             | 10   | 28.6%          |
| Lemongrass-Basil | 30                             | 18   | 60%            |
| Positive control | 35                             | 35   | 100%           |
| Negative control | 32                             | 0    | 0%             |

Table 5 interprets the data gathered within the three hours of the experiment. For lemongrass oil, the population started with 35 mosquitoes. 26 of them died, and it has a 74.3% mortality rate. For basil oil, the population started with 35 mosquitoes. 10 of them died, and it has a mortality rate. For the combined oil of lemongrass and basil, the population started with 30 mosquitoes. 18 of them died, and it has a 60% mortality rate.

The killing rate for lemongrass oil and the combination of lemongrass and basil oil continues to increase as the time duration also increases. In the 3 hours of experimentation, the average of lemongrass oil is 74.3%. It is because of the different active components that the lemongrass has that helps to kill

the mosquitoes (Plata-Rueda et al., 2020). While, 60% average in the lemongrass-basil oil. Both the lemongrass oil and lemongrass-basil oil reached the 50% killing rate which means that it is effective in killing mosquitoes based on the definition of lethal concentration wherein half of the population dies after a certain period of exposure (CCPS, 2023). The basil oil, on the other hand, continues to decrease as the time duration also increases. In this period of time, it has a mortality rate of 28.6%, it is very low compared to the average in the other time duration. Seeing that despite having different active components it is not enough to kill half the population of mosquitoes.

## Discussion

Mosquitoes can be seen anywhere and are most likely to breed inside the house. According to Omolade and Adetutu (2018), mosquito breeding takes place inside of homes as a result of human malarious lifestyles. Everything that can hold water, including plants, objects, and excavations, must be removed. Containers used to store water should always be covered.

The following concern above is still relevant at present times. This study aimed to differentiate the mortality rate of the organic anti-mosquito agent in different time durations. To extract the oil from the lemongrass and basil, the researchers cut the lemongrass into smaller pieces in order to fit into the RB flask while the basil remains as is. The researchers used the method that was described by (Katekar et. al., 2022) afterward.

The results from the performed mortality rate for the data that have been collected from the tests showed that there is a difference among the

three (3) oil extracted from the plant in means of their effectiveness as organic anti-mosquito agents when compared. As it was seen that the lemongrass oil has the highest mortality rate followed by lemongrass-basil oil, and then, basil oil.

For the duration of the organic anti-mosquito agents, it was seen that the longer the organic anti-mosquito agents are used, only the lemongrass oil and lemongrass-basil oil were seen that are effective in killing the mosquitoes, since among the three (3) oil their average is the only one that continues to increase as the time duration also increases.

## CONCLUSION

Among the different organic anti mosquito agents that were used in the experiment in the study, lemongrass oil and lemongrass-basil oil are the only effective among the three (3) plant extracts that were tested.

As the time duration increases, only the lemongrass and the combination of lemongrass and basil are the only effective in killing the mosquitoes.

Since the setting of the mosquito is most likely to manifest in the house, using this different organic anti-mosquito is an advantage as it is made in plant extract.

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